PLATE 6

STREET LAMP INSTALLATION, SHOWING SCROLL REVERSED TO OBTAIN REQUIRED CLEARANCES

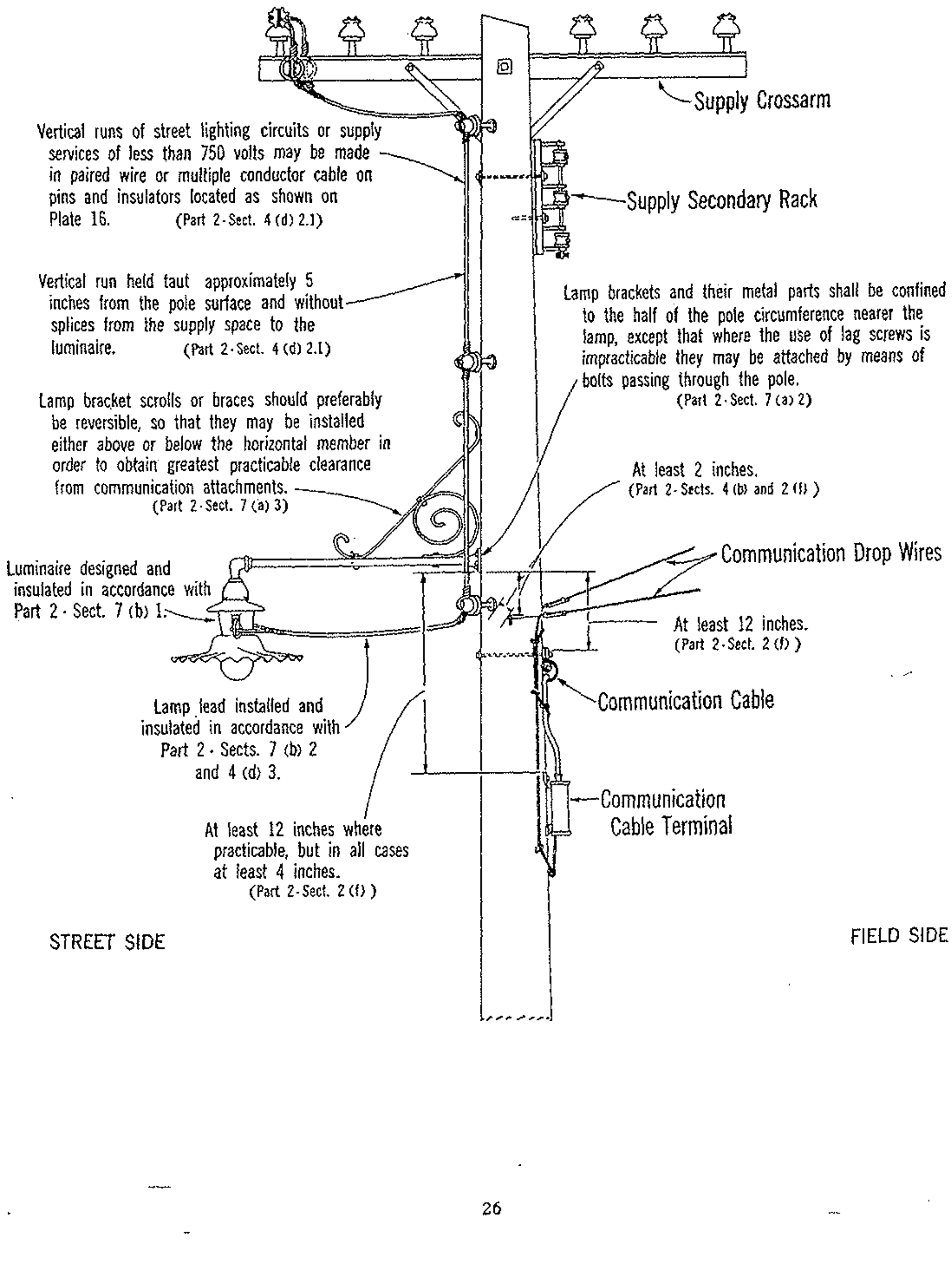
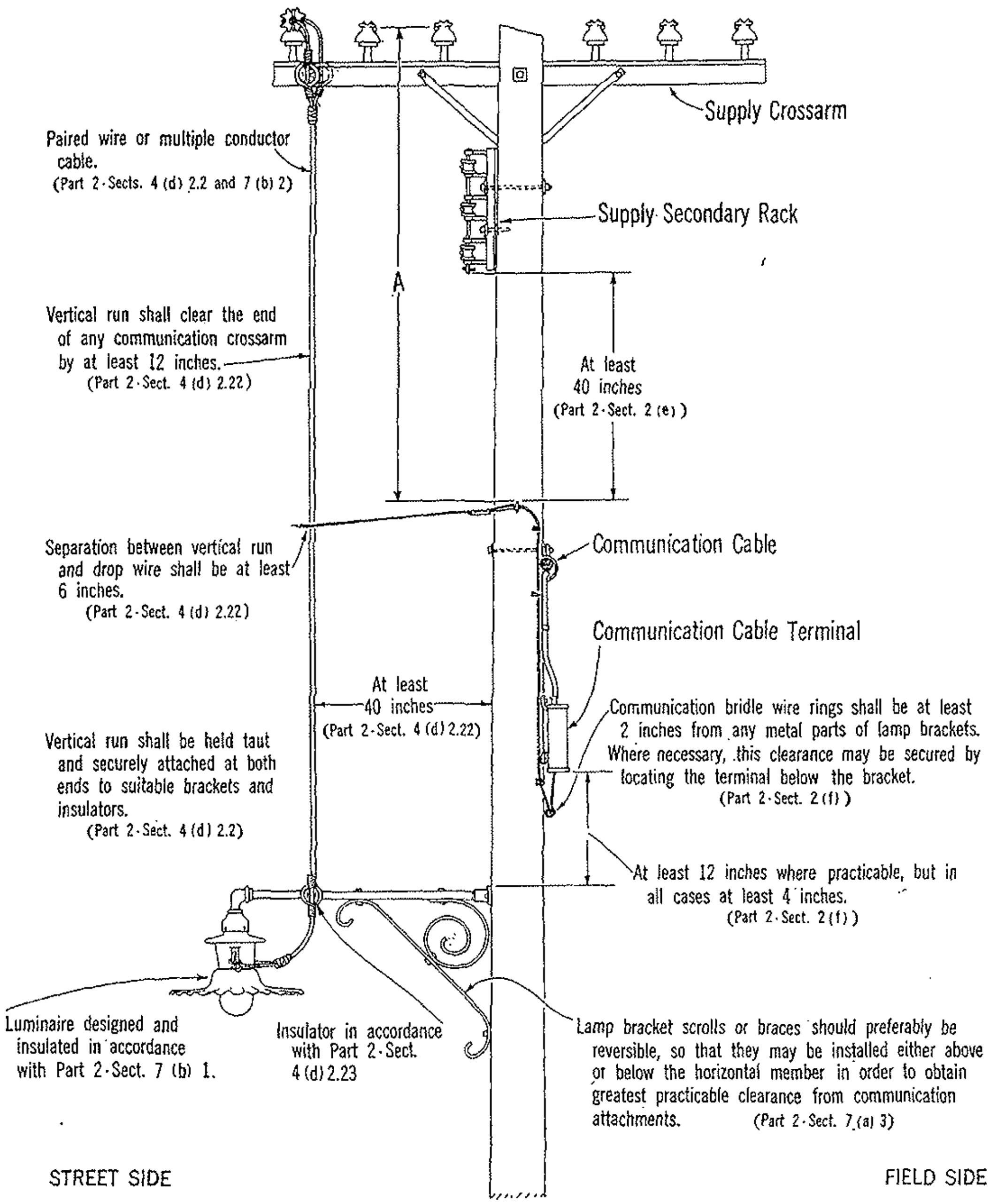


PLATE 7

STREET LAMP INSTALLATION, SHOWING VERTICAL RUN MADE DIRECTLY FROM END OF SUPPLY CROSSARM



Dimension	Voltage of Supply Circuit Concerned	Minimum Clearances (Inches)
A	0 - 7500	40
	750 - 7500	48
	Over 7500	72

(Part 2-Sect. 2 (e))

PLATE 8

ALLEY CONSTRUCTION, SHOWING VERTICAL RUN OF SUPPLY SECONDARY CONDUCTORS ATTACHED DIRECTLY TO THE POLE SURFACE

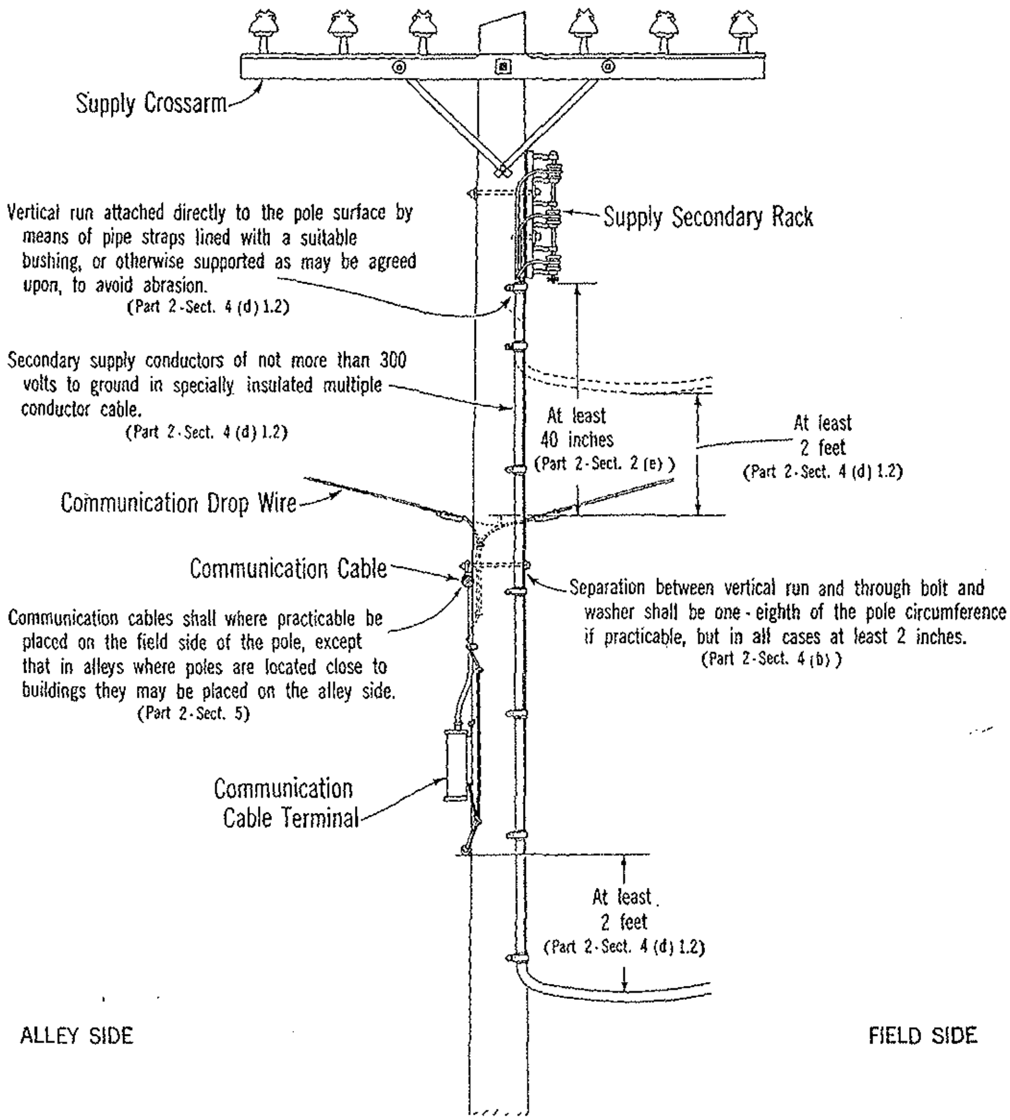


PLATE 9

LOCATION OF SUPPLY APPARATUS BELOW COMMUNICATION ATTACHMENTS, SHOWING ARRANGEMENT OF ATTACHMENTS AND POLE STEPPING

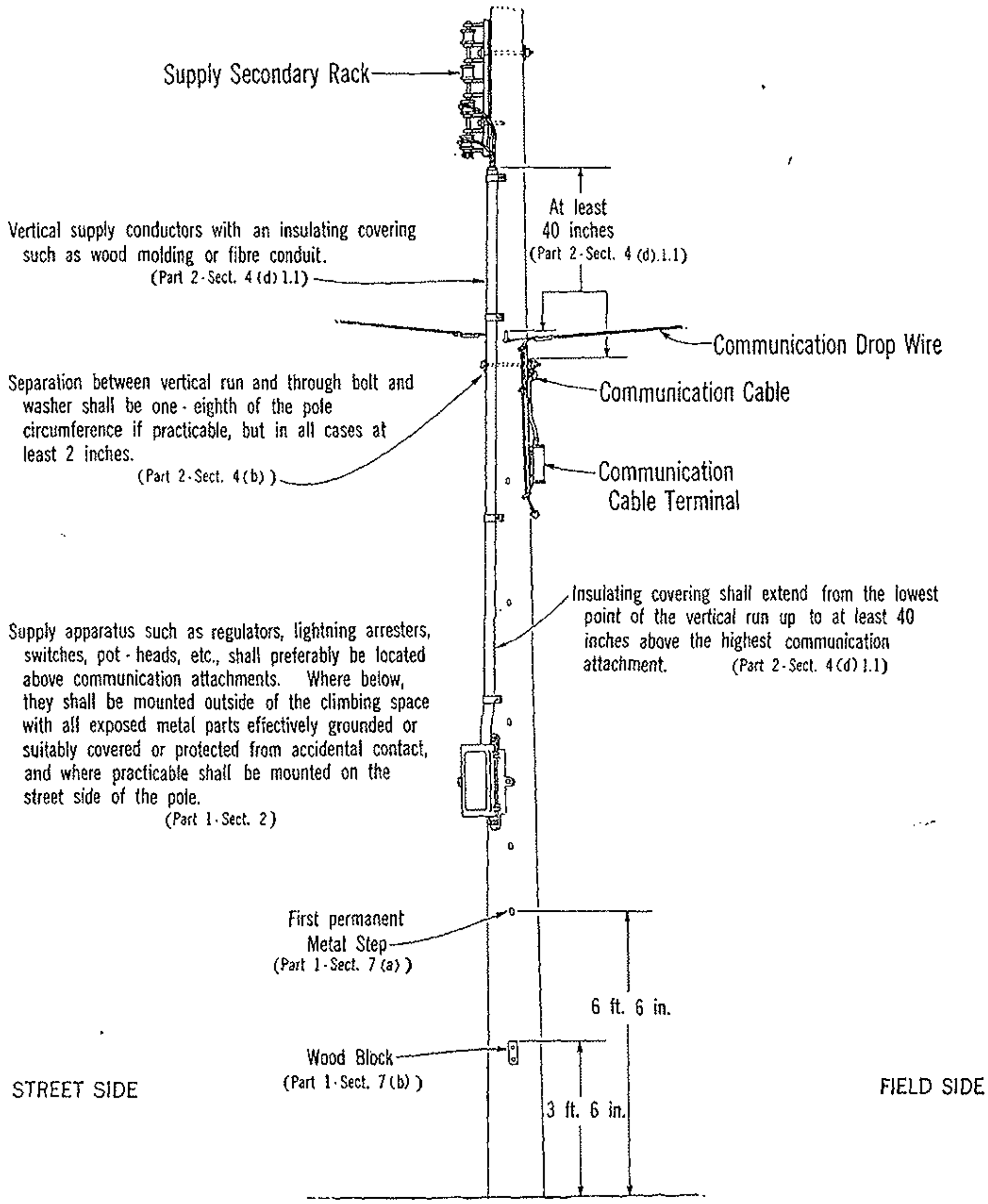


PLATE 10

SUPPLY CABLE CARRIED VERTICALLY THROUGH COMMUNICATION ATTACHMENTS

COMMUNICATION CABLE CARRIED VERTICALLY THROUGH TROLLEY ATTACHMENTS

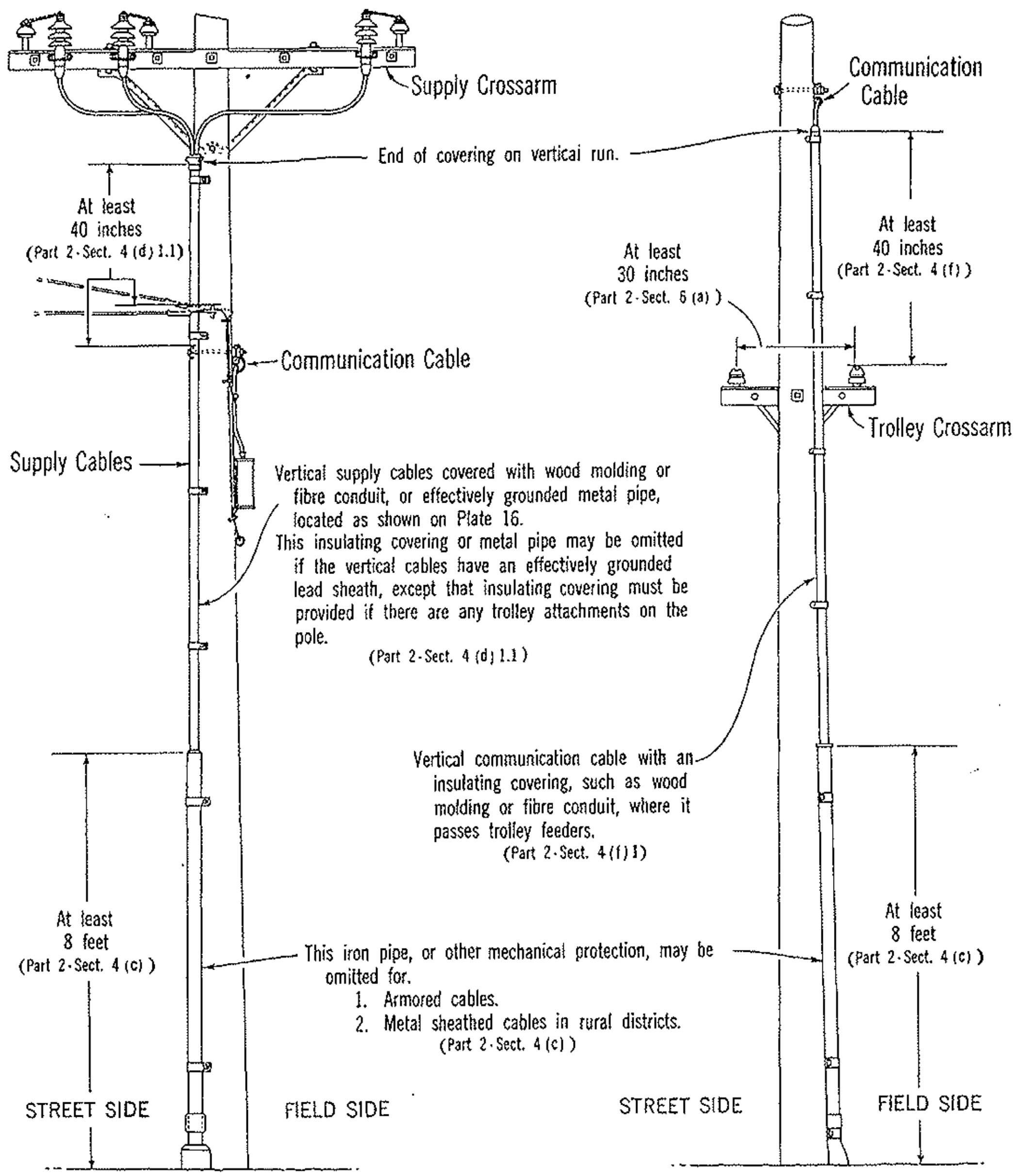


PLATE 11

SHOWING TROLLEY BRACKET CONSTRUCTION

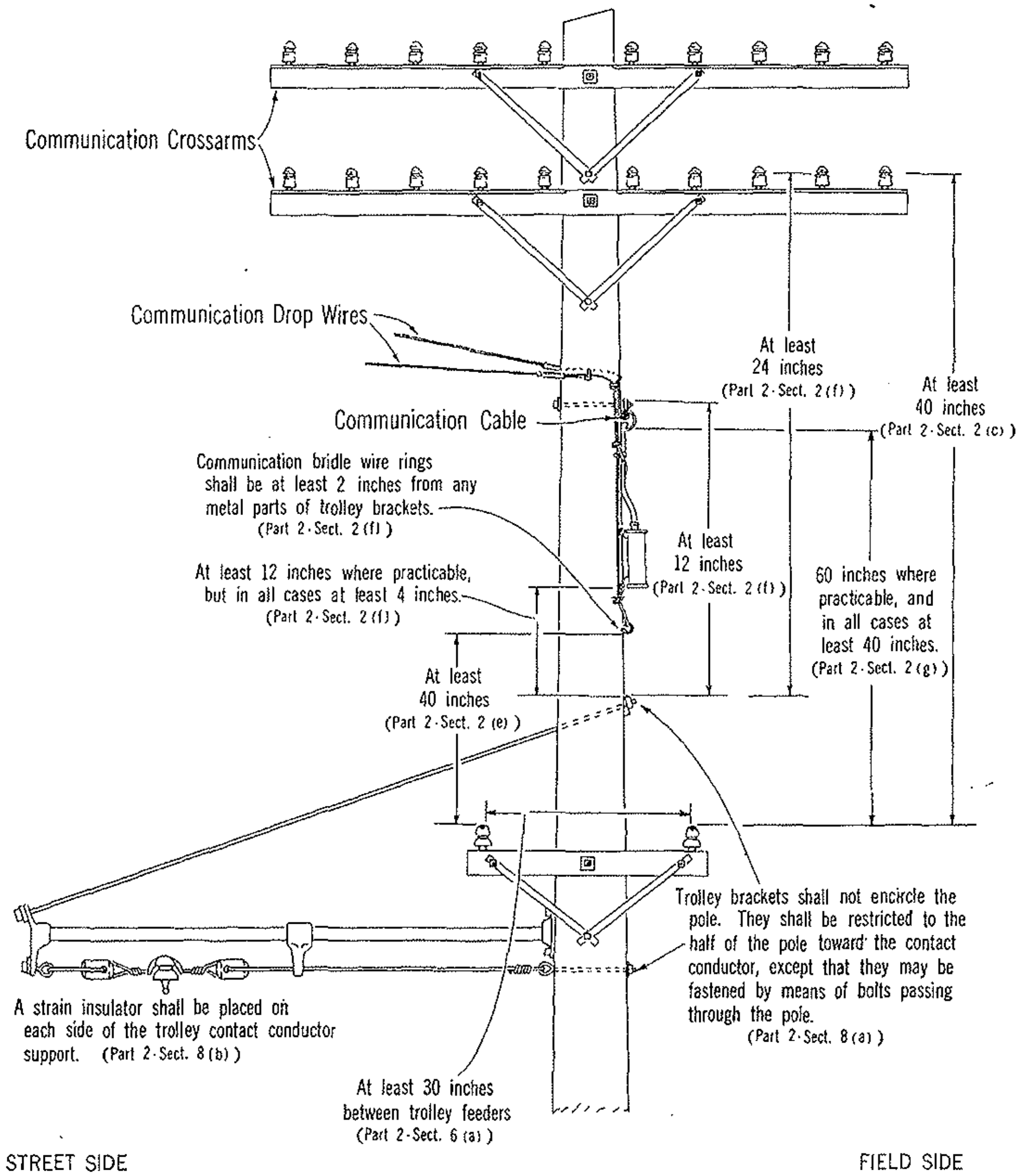


PLATE 12

SHOWING TROLLEY OR STREET LAMP SPAN WIRE CONSTRUCTION

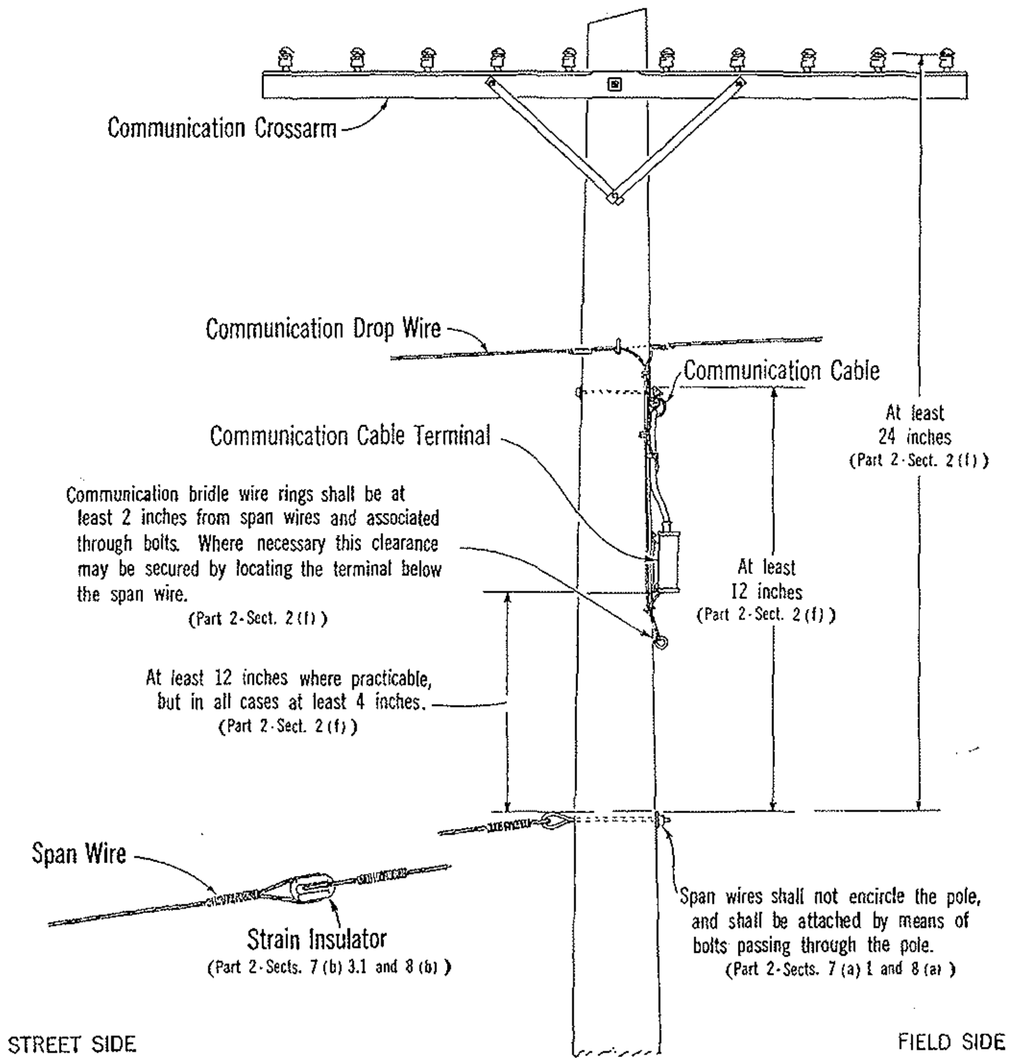
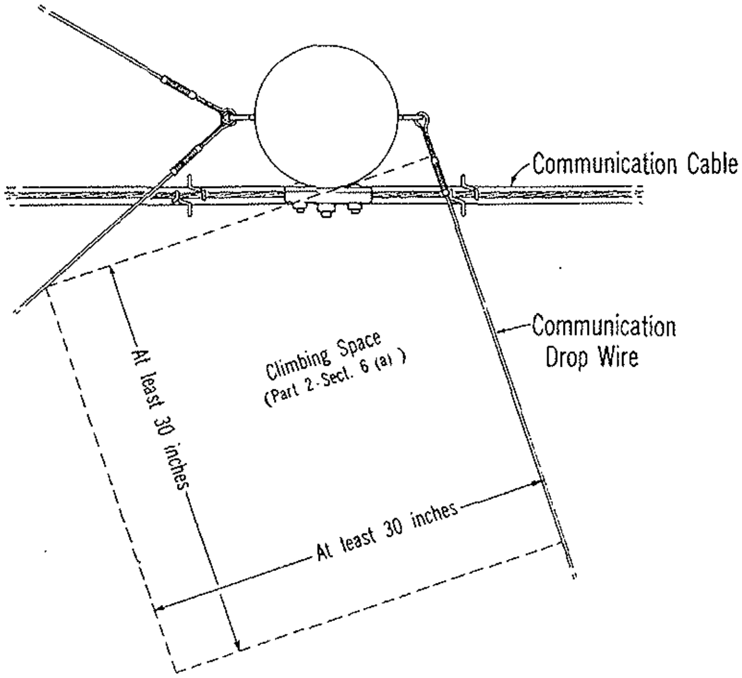


PLATE 13

SHOWING CLIMBING SPACE THROUGH COMMUNICATION DROP WIRES



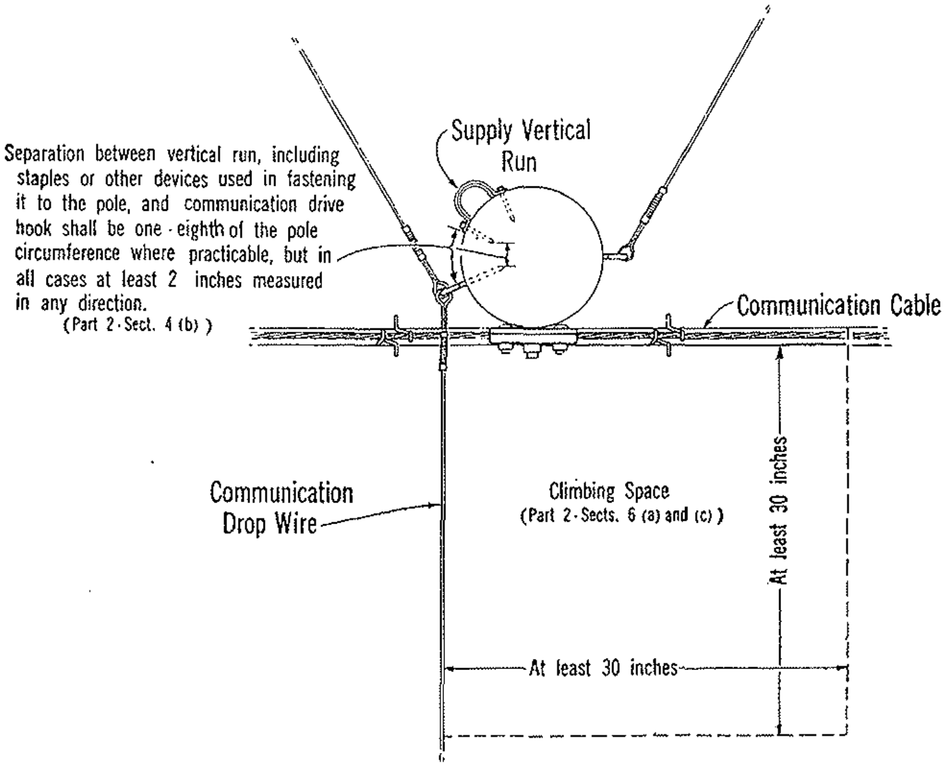


PLATE 14
SHOWING CONSTRUCTION WITH SUPPLY CABLE

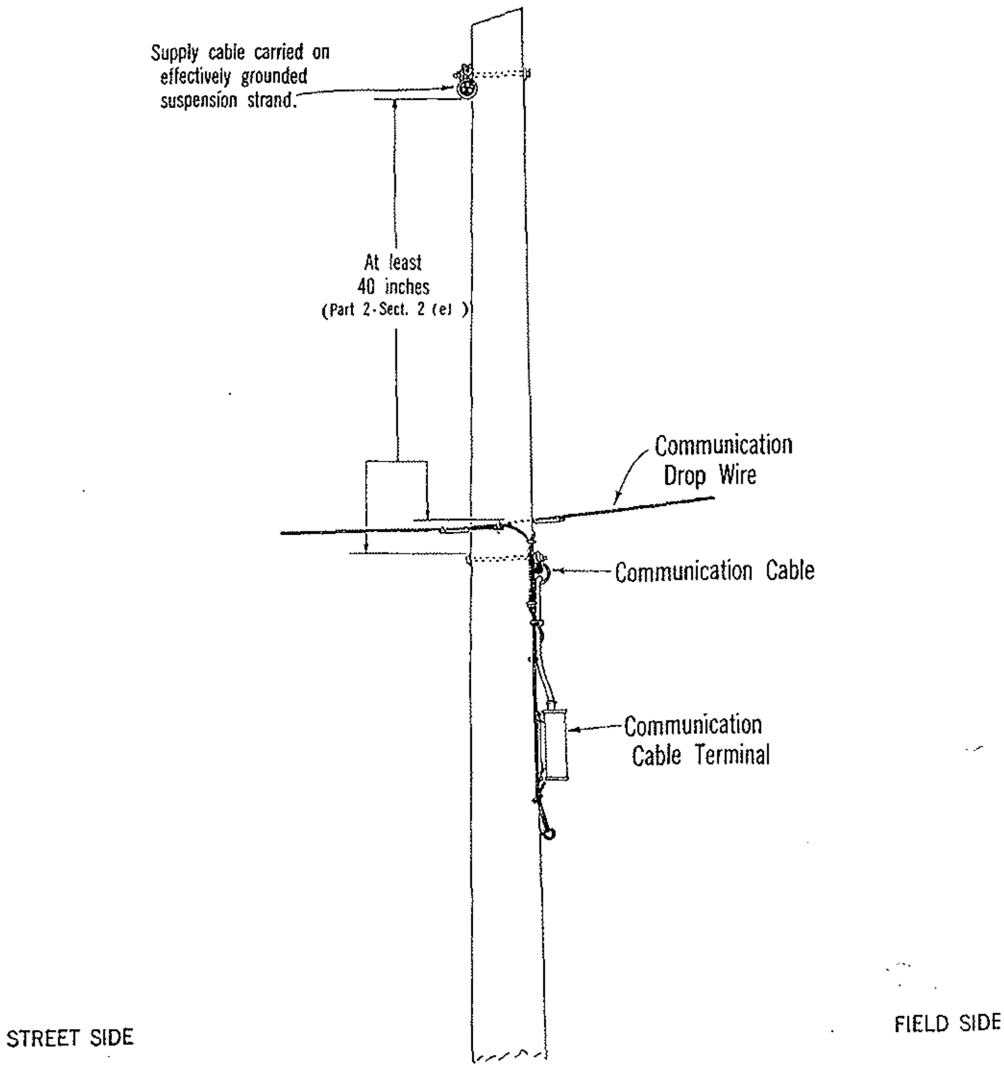


PLATE 15

SHOWING COMMUNICATION CABLE BETWEEN SUPPLY ATTACHMENTS AND TROLLEY FEEDERS

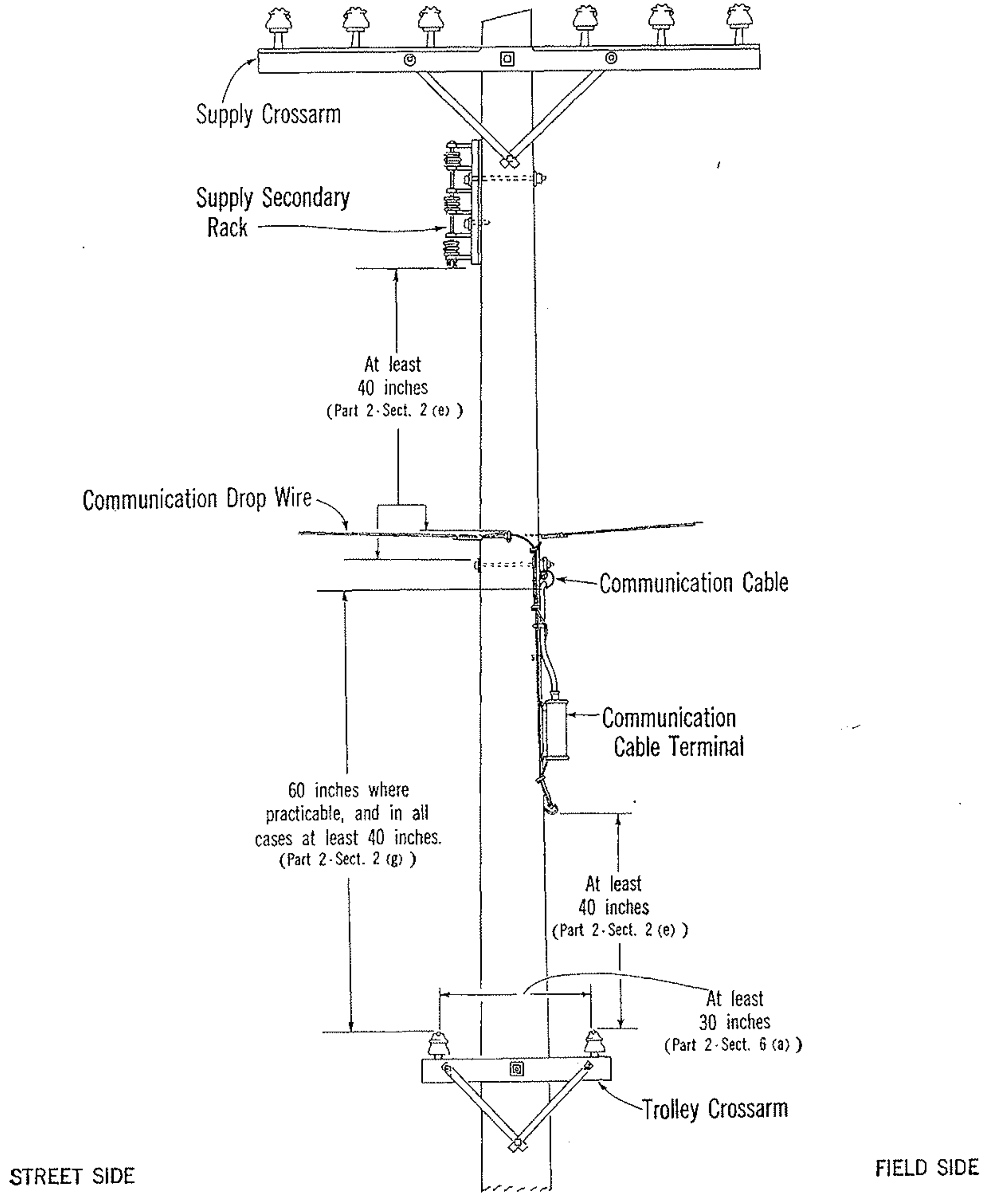


PLATE 16
LOCATION OF VERTICAL RUNS

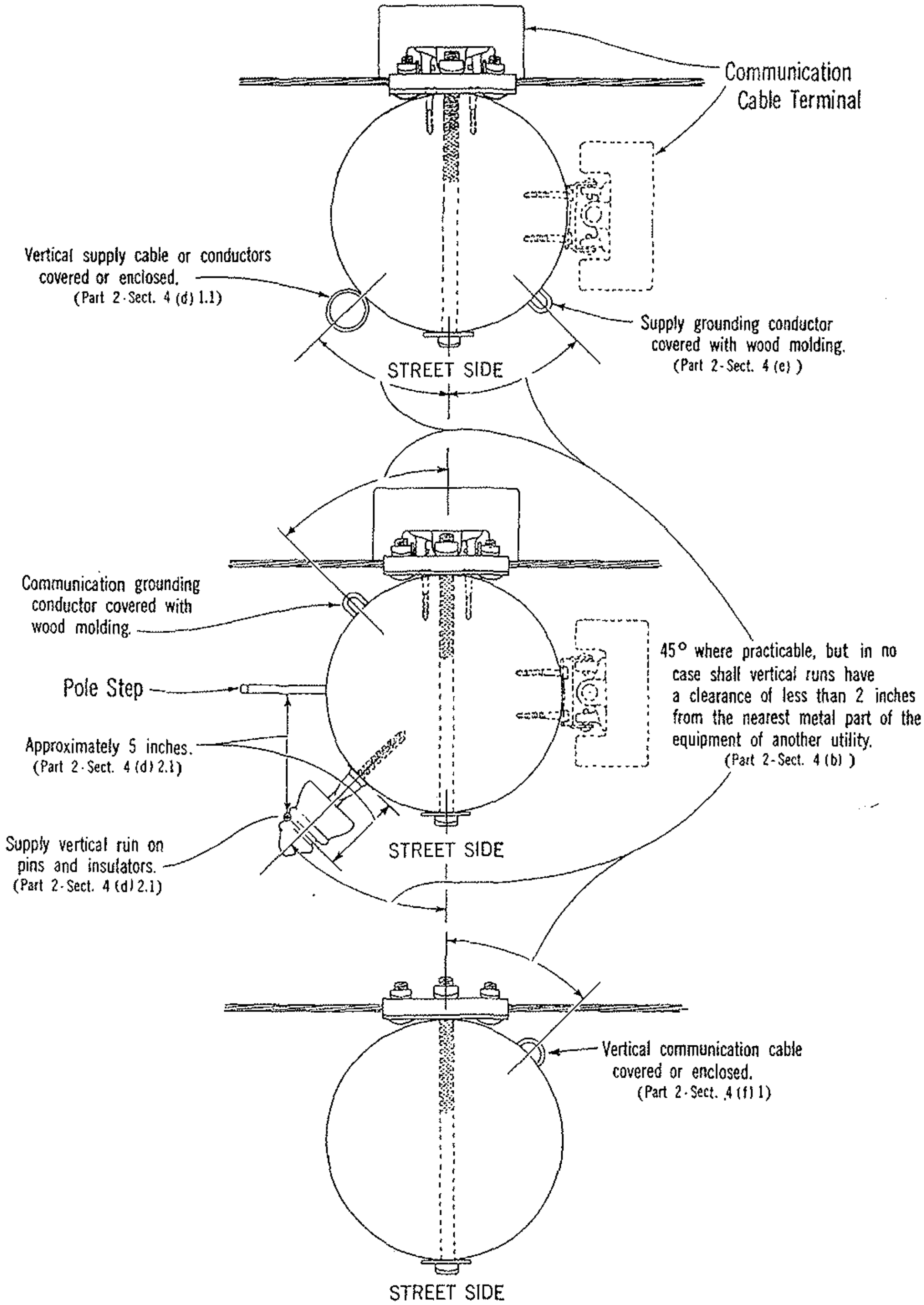


PLATE 17

TYPICAL SIGNAL LIGHT INSTALLATIONS

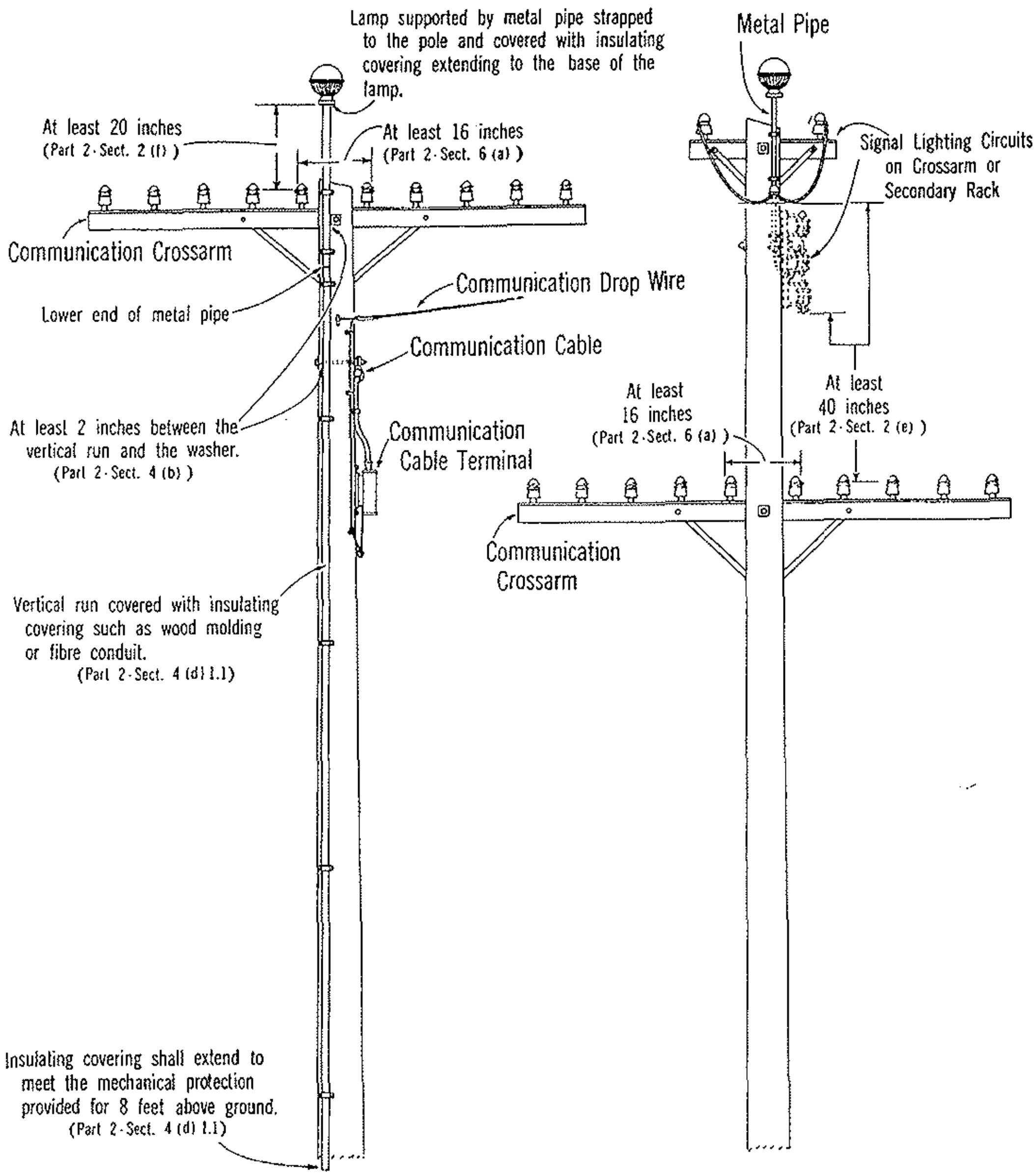


PLATE 18

USE OF STRAIN INSULATORS IN UNGROUNDED GUYS

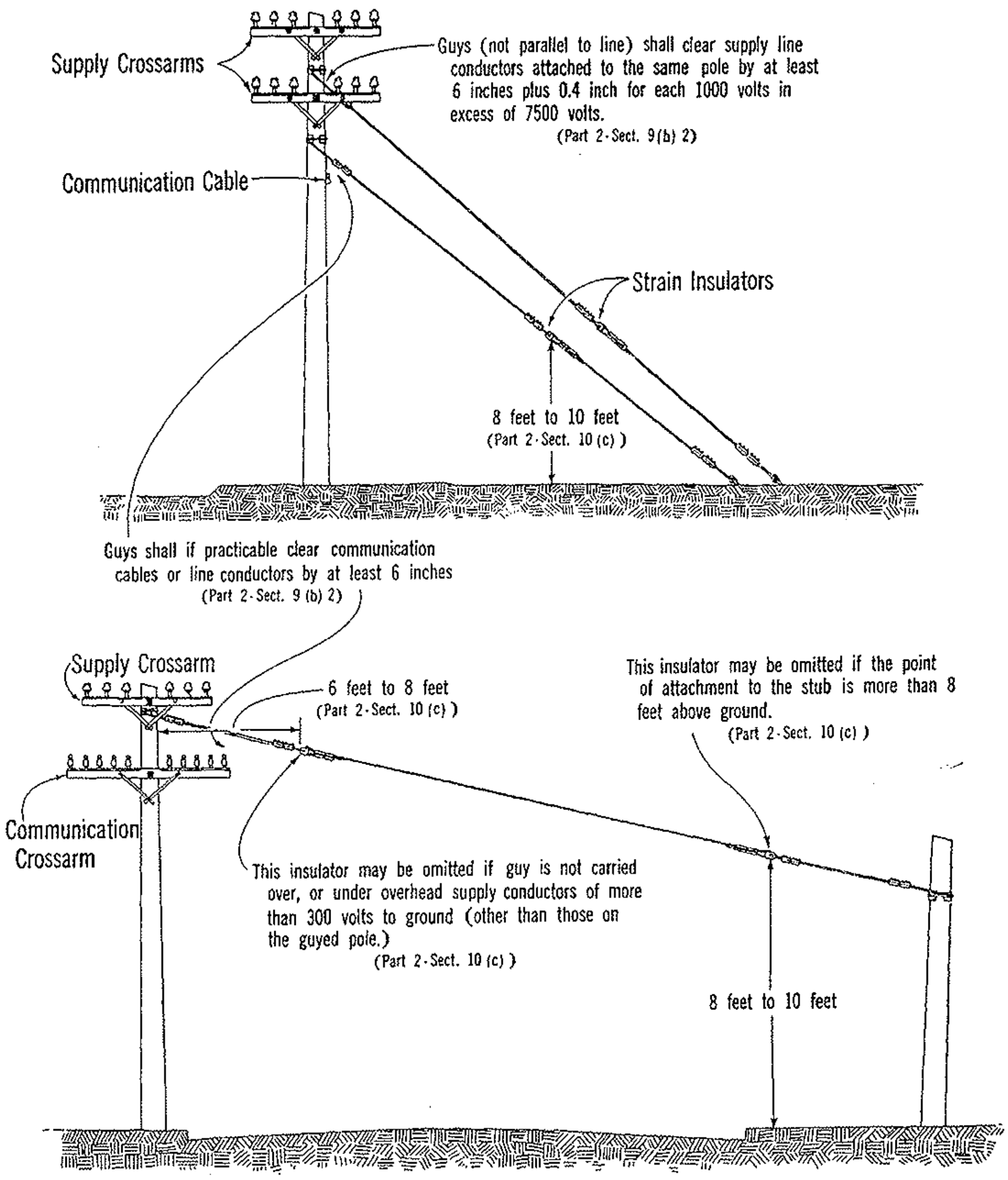
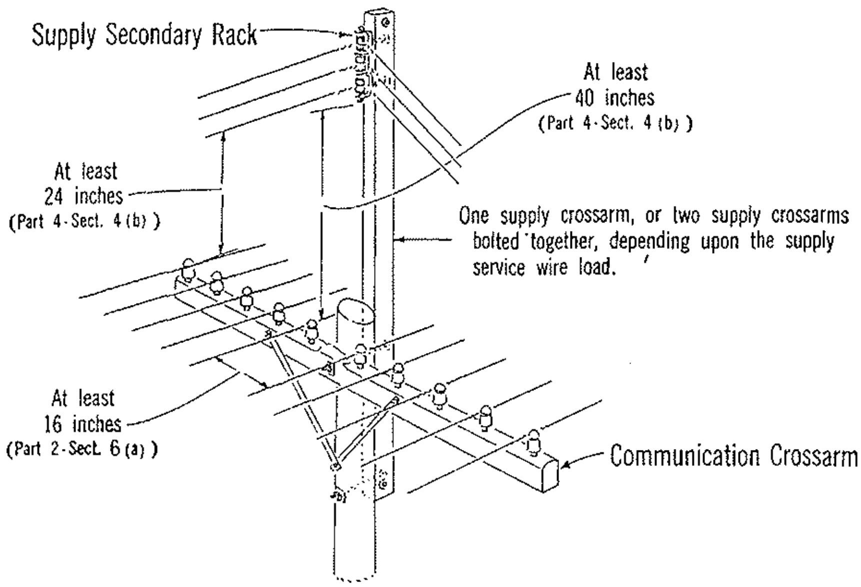


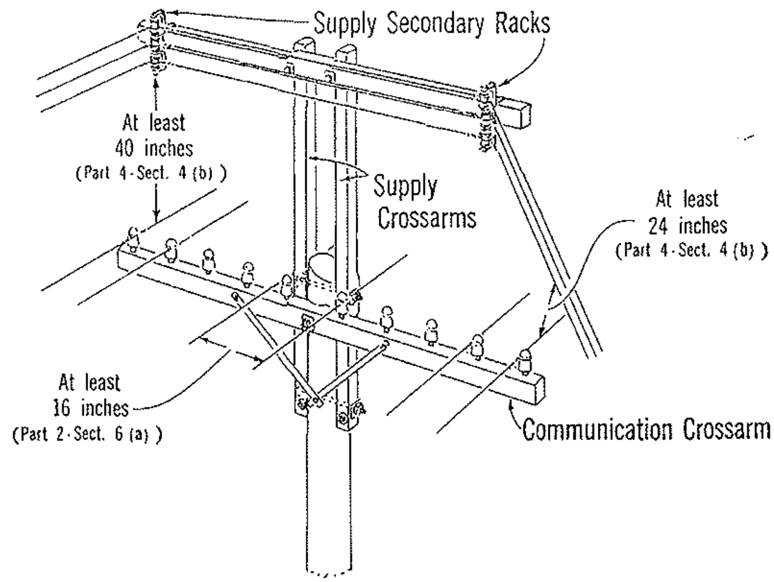
PLATE 19

TYPICAL POLE TOP EXTENSION FIXTURES

TYPE 1



TYPE 2



Notes:

Type 2 extension fixtures should be used only where Type 1 fixtures will not provide at least a 24 inch clearance between the supply service wires and the communication conductor on the end pin.

Where fixtures having a metal upright member are used, the supply service wires shall be supported on wood crossarms. (Part 4-Sect. 4)

EXHIBIT D2

2.9

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ANSWERED
FILE

JOINT USE OF POLES IN RURAL AREAS

A Report of the Joint Subcommittee on Joint Use of Poles for Rural Power and Telephone Circuits Edison Electric Institute and Bell Telephone System

Summary

This is a final report of the Joint Subcommittee on Joint Use of Poles for Rural Power and Telephone Circuits. The first report consisted of a preliminary issue of Part 5 "Special Considerations for Long Span Joint Use" of the Joint Pole Practices. This report reviews the factors concerned in the relative economies of joint construction vs. separate power and telephone line construction in sparsely settled rural areas and makes recommendations concerning further joint work on rural joint use matters.

October 1951

Copies of this report may be obtained by Power Companies from the Edison Electric Institute, 420 Lexington Avenue, New York 17, N. Y. (Publication 51-19) and by Associated Bell Companies from the Department of Operation and Engineering of the American Telephone and Telegraph Company, 195 Broadway, New York 7, N. Y.

CONTENTS

EDISON ELECTRIC INSTITUTE

BELL TELEPHONE SYSTEM

JOINT COMMITTEE ON PLANT COORDINATION

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H E Kent, Secretary		S B Graham, Secretary	

JOINT SUBCOMMITTEE ON JOINT USE OF POLES FOR RURAL POWER AND TELEPHONE CIRCUITS

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JOINT USE OF POLES IN RURAL AREAS

Under date of October 29, 1945, the Joint Committee on Plant Coordination issued a report covering the construction and maintenance of jointly used pole lines carrying supply and communication circuits which was designated as "Joint Pole Practices." These Practices are divided into four parts intended for application under the various conditions which obtain generally in urban and suburban areas. Because of limited experience it was not practicable to include in the Joint Pole Practices requirements covering long span joint use such as obtains in rural areas. Provisions were, therefore, made for a Part 5 which could be added later to cover the clearance and other requirements involved in such joint use.

Early in 1946, the Subcommittee on Joint Use of Poles for Rural Power and Telephone Circuits was formed and instructed to study the factors involved in the joint use of poles for rural power and telephone circuits including the guidance of trial installations with the objective of developing:

(a) Suitable specifications for the construction of long span joint use.

(b) The economies of rural joint use as compared with separate lines.

(c) Sound and equitable principles and practices for guidance in negotiating administrative and contractual relations.

These instructions also included application of available methods of inductive coordination and electrical protection on the power and telephone circuits.

Specifications

Under date of April 10, 1946, the Subcommittee on Joint Use of Poles for Rural Power and Telephone Circuits submitted tentative specifications for long span joint construction. These specifications were prepared in the form of Part 5 of the Joint Pole Practices and were intended to be used in combination with such of the other requirements of the Joint Pole Practices as apply.

In line with the recommendations of the Subcommittee, the Joint Committee on Plant Coordination issued Part 5 for field trial on May 6, 1946, and copies were sent to Member Companies of the Edison Electric Institute and Associated Companies of the Bell Telephone System.

Basic Considerations

In its studies of long span joint use, the Subcommittee has found it convenient to group the factors concerned under three headings, namely, Structural Coordination, Electrical Protection and Inductive Coordination.

Structural Coordination

The important factors involving Structural Coordination in long span joint use are:

1. Separations between power and telephone wires at the pole and in the span.

2. Clearances of power and telephone wires above highways and above ground along highways and over ways generally.

3. Pole sizes to provide required strengths and wire clearances.

Minimum requirements covering these factors are contained in Part 2 of the 5th (Current) Edition of the National Electrical Safety Code. Joint use has been employed in urban and suburban areas for many years, and patterns of joint use have been developed which have proven generally satisfactory in such areas. With the development of relatively small, high strength power wires, the construction of power lines in span lengths 2 to 5 times longer than those normally used in urban areas, became practicable. Also, the development of improved high strength telephone wires made practicable the construction of correspondingly long span open wire telephone lines. Joint use with such wires in long spans was not contemplated in Part 2 of the Current Edition of the National Electrical Safety Code and the need of guides, particularly concerning separations between power and telephone wires at the pole and in the span, was indicated. Part 5 of the Joint Pole Practices referred to above, was intended for this purpose.

Electrical Protection

Previous to 1930 a large percentage of power distribution circuits involved in joint use ranged between 2300 and 4800 volts and adequate practices for such joint use had been developed based on experience. However, the situation was less clear where higher distribution voltages were involved, and the Joint Subcommittee on Development and Research consequently undertook a study of the problem, the results of which were given in Provisional Report 19, entitled "Joint Use of Poles - Telephone Circuits and 6.6 and 13.2 Kv Power Circuits - Safety Features." Out of these studies there developed the following basic concepts which facilitated the extension of joint use with power circuits in higher voltage categories.

1. Protection of telephone plant in joint use requires coordination of protective devices in both the power and telephone circuits.

2. Such coordination consists in essence of provision for positive deenergization of the power circuit in case of fault to ground, and limitation of the voltages on the telephone plant in case of accidental contact to the range of safe operating characteristics of telephone protective equipment. On open wire telephone circuits this involves the use of auxiliary protectors associated with telephone line wires which will (a) limit the voltage at the telephone station to the protective equipment operating range and (b) provide for impedance to ground low enough and with current carrying capacity high enough to assure the operation of power protective equipment in the event of accidental contact. On telephone cable and associated drop wire, the effective grounding of the telephone cable sheath -- in some cases bonding the sheath to the multi-grounded neutral of the power system -- provides suitable limitation of impressed voltage.

The auxiliary protector used on open wire telephone circuits where exposed to contact with higher voltage conductors, has been standardized and is known as the 99A protector. It consists of three carbon cylinders, each about 5/8 inch in diameter, and 1/2 inch long, inclosed in a mounting suitable for attachment to a pole or telephone crossarm. The carbon cylinders are spaced to give approximately 3000-volt gaps. Two of the cylinders are connected to the wires of the telephone circuit concerned and the third is grounded, where practicable to a grounding wire which is also connected to the multi-grounded neutral of the power system.

These methods of protection, developed primarily for application to joint use in urban and suburban areas, are equally applicable to joint use in rural areas where higher voltage multi-grounded neutral distribution circuits are employed. In rural areas, however, where telephone circuits may be involved in considerable lengths of joint use, the matter of electric or magnetic induced voltages on telephone wires may be of importance. To take care of this problem, there has been developed a drainage protector for use on open wire telephone circuits. This device is in two forms, one consisting of a resistor in series with a capacitor and the other of a reactor in series with a capacitor, the combination tuned to 60 cycles. Since these drainage devices are connected between each wire of a telephone circuit and ground, it is important that their bridging impedance be high so as not to cause high telephone transmission losses and low as regards impedance to ground, so as to limit induced voltages to ground. The device with resistors is known as the 104A telephone protector and the one with reactors is known as the 108A telephone protector. The 104A is designed for electric induction only; the 108A, while designed primarily for electric induction, is also effective for magnetic induction if the impedance of the line to which it is connected is relatively high.

In urban and suburban areas, joint use largely involves telephone cables and relatively short extensions of open wire. Where these open wire extensions are joint with higher voltages, 99A protectors are usually employed but drainage protectors are seldom required. In rural areas, where open wire telephone circuits are usually relatively long, both types of protectors are indicated where higher voltage power circuits are involved. Where the power circuit operates at less than 3000 volts to ground, 99A protectors are not applicable but drainage protectors may be indicated.

Inductive Coordination

The principal problem of inductive coordination in rural joint use involves "noise induction" in open wire telephone circuits. Studies in this connection indicate the importance of the following:

1. That the power circuits concerned have reasonably low values of harmonics.

2. That the telephone circuits be well balanced as regards impedance to ground and that they be adequately transposed throughout the extent of joint use and other parallel construction.

Well balanced telephone equipment both at telephone central offices and at telephone stations are indicated where rural power and telephone circuits operate in the same territory in joint use or in parallel construction. A system of telephone circuit transpositions, known as the R System, has been developed which is applicable to open wire telephone circuits in either paralleling construction or joint use and has been found to be effective when employed in combination with well balanced equipment at the central office and at subscriber stations as referred to above. With this system of telephone transpositions, each telephone circuit is transposed at alternate poles if long span construction is used; with short span construction transpositions are made at about the same linear intervals, rather than at alternate poles. Where two or more circuits are involved, the transposition locations are staggered to minimize telephone cross-talk induction. An important feature of the system is the use of a tandem-type transposition bracket.

Trial Installations

During 1946, a number of trial installations of long span higher voltage rural joint use were constructed. Data on five of these installations, three in the light and medium loading districts and two in the heavy loading district, were made the subject of a paper on Joint Use of Pole Lines for Rural Services presented at the 1947 Winter meeting of the American Institute of Electrical Engineers by Messrs J W Campbell of the American Telephone and Telegraph Company, L W Hill of the Carolina Telephone and Telegraph Company, L M Moore of the Rural Electrification Administration and H J Scholz of the Commonwealth and Southern Corporation. (Transactions of the American Institute of Electrical Engineers, Vol. 66, pp 519-524, 1947.) This paper described the means employed in the five installations for the coordination of construction, electrical protection and induction and gave the results of noise measurements on the telephone circuits in each instance. This paper indicated that the trials made up to that time had demonstrated the feasibility of higher voltage long span joint use in rural areas.

In many locations throughout the country, particularly surrounding larger cities, joint use has extended into rural areas with the same pattern of construction and the same power system voltage as employed in the urban areas. In more thinly populated rural areas, long span higher voltage joint use has been constructed in many instances. It is estimated that at present there are of the order of 2,000,000 poles jointly used in rural areas in the United States and that about 300,000 of these involve joint use of the long span higher voltage type.

Economies of Rural Joint Use as Compared with Separate Lines

In its studies of the relative economies of rural joint lines as compared with separate lines, the Subcommittee has confined its considerations primarily to situations such as obtain in thinly settled rural areas where higher voltage power circuits, long spans and long open wire telephone circuits are indicated. In considering the costs of joint lines as compared with separate lines in such situations, certain elements of cost are involved which are not present in the same degree in urban types of joint use. The procedure has, therefore, been to investigate the cost of separate rural power and telephone lines including in each case the cost of poles in place, the cost of rights-of-way, initial clearing, recurrent trimming, and added costs such as are involved where the lines cross each other. On joint lines there have been included the costs of poles in place, rights-of-way, initial clearing, recurrent trimming and additional electrical protection. For situations in which joint use is established on existing rural power lines there has also been included in the joint line costs, the added cost to the Telephone Company of stringing wire under energized power wires and the added cost of rearrangement of power facilities, added poles and pole replacements. Thus the effort has been to compare the over-all costs of separate rural power and telephone pole lines with the over-all costs of joint pole lines in the same territory.

These cost items vary considerably depending on the circumstances which obtain in different territories. For example, initial clearing and recurrent trimming costs may be high in some localities and low in others. The cost of poles in place vary considerably in different parts of the country. In general, however, the factors which cause these variations apply to the lines built separately by the Power and Telephone Companies and to joint lines.

In addition to the factors reviewed above and to which dollar values can be assigned, there are also certain other items, important in the consideration of joint versus separate lines, but to which it is not practicable to assign dollar values.

In its studies of relative economies the Subcommittee has been guided by the following factors.

1. So far as the inductive influence of the power system and the inductive susceptiveness of the telephone system are concerned, these would equate to the same problem in joint use as in parallel construction on the opposite side of the highway. Therefore, joint use as of itself would not add to the cost of inductive coordination in joint construction.

2. As regards electrical protection, since the protective devices usually employed on the rural power system provide for de-energization at times of ground faults, and since the protective devices designed for use on telephone circuits result in ground impedances such as are usually employed by power companies in this connection, no additional expense on the power system pertinent to joint use would be involved. On the telephone system there would be involved the expense of a greater number of 99A protectors and drainage protectors than would be required for separate lines.

3. In constructing lines in rural areas there are usually involved rights-of-way, initial clearing and subsequent trimming costs. These costs would be applicable to separate lines and to joint lines.

4. In establishing new separate rural power and telephone lines, crossings of the two lines are involved at intervals, as for example at cross roads, service drops, etc. A certain amount of expense would be involved to provide the required strengths, clearances and electrical protection at many of these crossings. Such expense, assumed paid by the second comer, would be chargeable to the cost of separate lines.

5. The joint lines has been assumed to be a line suitable for both services without regard to height or class of poles, i.e., no normal joint pole.

6. In establishing joint use on existing lines, some rearrangement of existing facilities, replacement of poles, and provision of additional poles may be required. Such expense would be chargeable to the cost of the joint line.

7. The stringing of telephone wires under energized power conductors requires particular care to prevent contacts between the telephone wires and energized power wires which add to the cost of stringing telephone wires. In building new joint use lines, the work could be so planned as to avoid this added expense in connection with the telephone wires to be installed initially.

8. Since the number of poles per mile used by power and telephone companies on their normal separate line construction may differ, and since many of the cost items mentioned in the preceding can best be compared on a unit length of line basis, it is convenient to make cost comparisons on the basis of annual charges per mile. This permits the direct inclusion in the comparison of the annual cost of recurrent trimming where this item is of importance.

9. There is likely to be more costly damage and greater delay in clearing trouble due to storms when power and telephone wires are attached to the same poles. However, it was not practicable to arrive at a suitable valuation of this item.

With these factors considered, the studies of the Subcommittee have led to the conclusion that, in general, joint use in sparsely settled rural areas may offer opportunities for dollar economies. These opportunities for dollar economies are, of course, greatest where new joint lines are constructed. Where existing power lines are to be rearranged for joint use opportunities for dollar economies will be considerably reduced. Where existing rural telephone lines or existing rural power and telephone lines are involved, joint use, in general, offers no dollar economies but in some instances, may be the best engineering solution to specific problems.

Joint Use Arrangements in Rural Areas

The EEI-Bell System "Principles and Practices for the Joint Use of Wood Poles by Supply and Communication Companies" as issued by the Joint

General Committee in 1926 and reissued without change in 1945, has formed the basis for a large percentage of the more than 300 joint use agreements now in effect between power and telephone companies in the United States. These agreements have established general patterns as to form which are adaptable to the conditions obtaining primarily in urban and suburban areas. As affecting thinly settled rural areas, a sufficient number of agreements have not so far been executed to establish a general pattern for such specific joint use. However, it is believed that the first sentence of Item 2 of the EEI-Bell System Practices referred to above should form a reasonable basis for joint use arrangements in rural areas. This sentence is as follows: "Joint Use Agreement should preferably be of a type under which each of the parties shares equitably in the cost of joint poles."

Recommendations

In completing its assignments, the Subcommittee makes the following recommendations:

1. That this report be issued to the power and telephone companies as a Subcommittee Report.

2. That consideration be given to combining trial Part 5 covering long span joint construction, with the Joint Pole Practices and that in this connection, consideration also be given to such of the recommendations contained in Provisional Report No. 32 of the Joint Subcommittee on Development and Research entitled "Factors Which Influence Pole Height in the Rural Joint Use of Poles" as are mutually acceptable.

3. That work be continued through appropriate channels with the objective of promoting safety and economy in joint use.

EXHIBIT E

Section 2

PLANNING

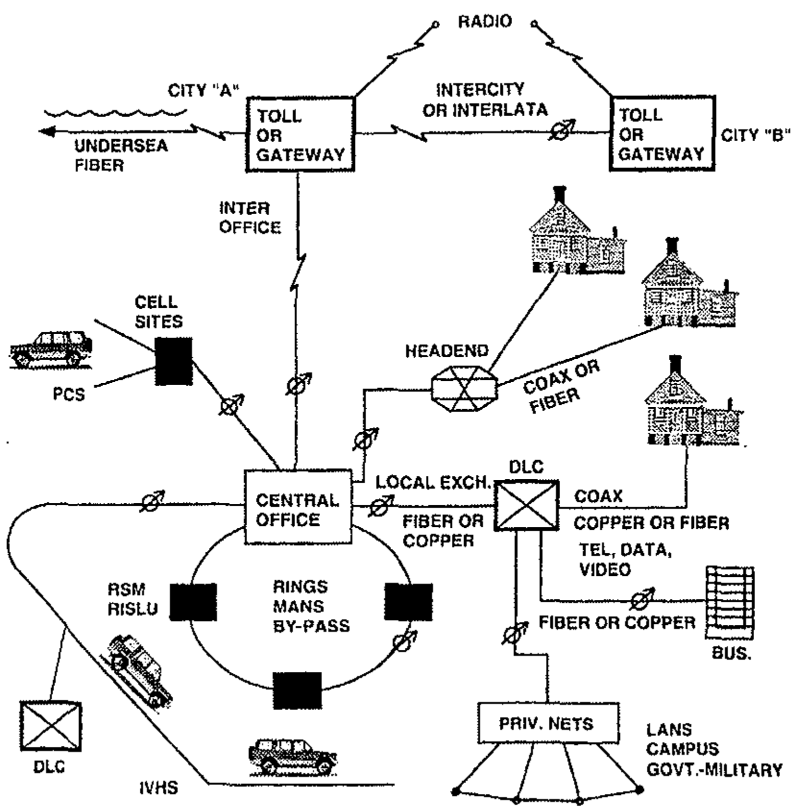
AT&T OSP SYSTEMS

Outside Plant (OSP) Systems capability is represented by the global pipeline diagram on the next page. This global pipeline includes the following types of networks:

- Intercity or Interlata — Long distance fiber optic networks for high-speed information transport between cities
- Interoffice — Intercity junction networks that connect central offices and local exchanges
- Local Exchange — Loop distribution networks, which provide homes and businesses with access to communications services.

These networks may be adapted for the following applications:

- Cable Television
- Metropolitan Area Networks
- Local Area Networks
- Intelligent Vehicle Highway Systems
- Cellular
- Rings
- Private Networks.



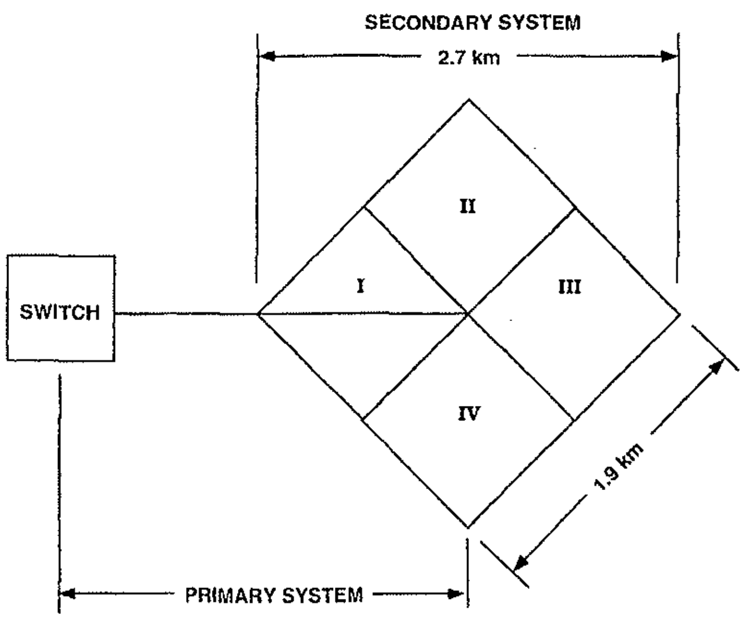
OSP Capability - The Global Pipeline

LOCAL EXCHANGE PLANNING

Planning in the Local Exchange begins with a Geographic Model. There are two systems (segments):

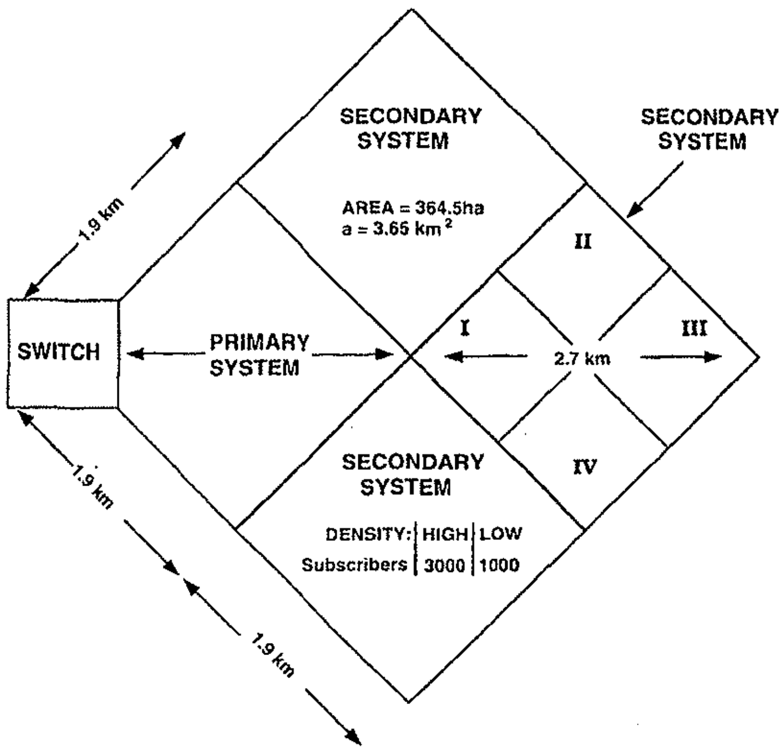
- Primary System (Feeder)
- Secondary System (Distribution).

Following are two examples of geographic models showing Primary and Secondary Systems. Notice that there can be multiple Secondary Systems fed from a serving switch.



Geographic Model - Primary System

The dimensions and density of the Secondary System models may vary due to the characteristics of the geographic area. For example, a Secondary System model can be further subdivided into four smaller segments if required for high density. This is indicated in the example by Roman Numerals I — IV.



Geographic Model - Secondary System

Primary System Transport options include:

- Copper
- Conditioned Copper
- Fiber
- Radio.

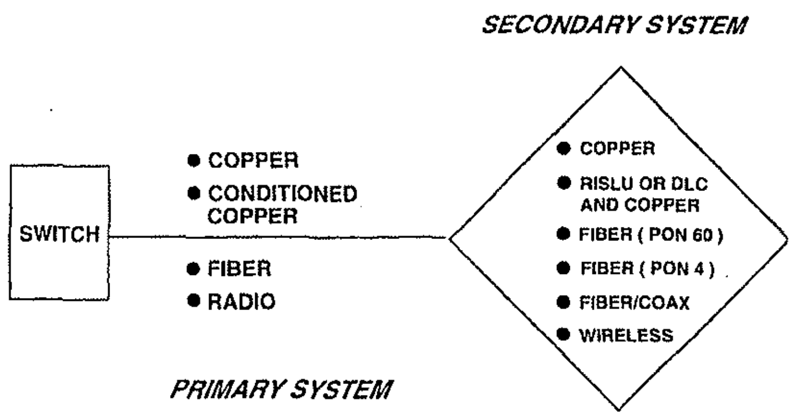
Secondary System Transport options include:

- Copper
- Digital Loop Carrier/Remote Integrated Services Line Unit (RISLU) + Copper
- Fiber (Passive Optical Network [PON 60/PON 4])
- Fiber/Coax
- Wireless.

Transport selection is based on the following considerations:

- Customer Requirements
- Distance and Density
- Proposed Location (topography, accessibility)
- Voice Service and Video Decision Tree (Community Antenna Television [CATV])
- Cost Models.

A diagram showing the Primary and Secondary System Transport options is shown on the next page.



Transport Options

Model Comparisons

Cost Model comparisons are made including:

- Classic Copper both in Primary and Secondary Areas
- A mix of copper and fiber using RISLU or Optical Loop Carrier (OLC) 2000
- A PON Network using Optical Network Unit (ONU) 60
- A PON Network using ONU 4
- Fiber/Coax.

Cost Parameters PON

PON 60 System:

- Cost of concentrated 2 Mb/s (V5.2) on host
- Cost of Optical Line Terminals (OLTs) and ONU 60 inclusive of installation and local powering of ONUs
- Cost of optical cables in Primary and Secondary areas inclusive of trenching, installation, OSP material, and 1:3 splitters
- Cost of Secondary copper cable inclusive of trenching and OSP material
- Installation of OSP.

PON 4 System:

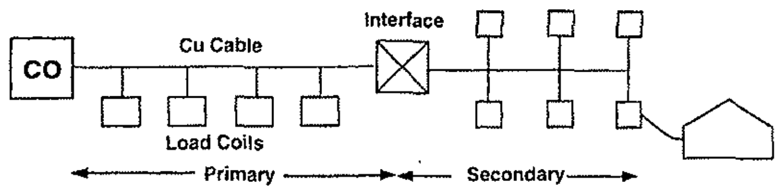
- Cost of concentrated 2 Mb/s (V5.2) on host
- Cost of OLTs and ONU 4 inclusive of installation and centralized powering of ONUs 4
- Cost of optical cables in Primary and Secondary areas inclusive of trenching, installation, OSP material, and 1:32 splitters
- Cost of Secondary copper cable inclusive of trenching and OSP material
- Installation of OSP.

Note: For centralized powering of the ONUs, a combined fiber/copper cable was used.

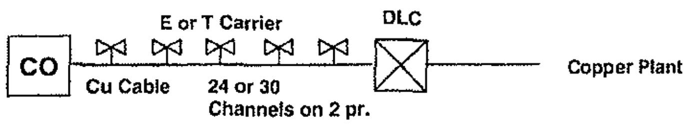
LOCAL EXCHANGE ARCHITECTURE

Examples of loop architectures include:

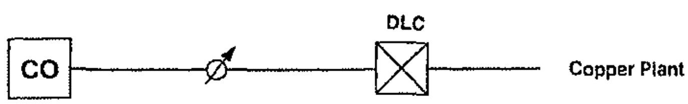
- Classic Copper
- Conditioned Copper Primary + DLC Copper Secondary
- Fiber Primary + DLC Copper Secondary
- Fiber Primary + RISLU Copper Secondary
- Fiber to the Curb
  - Active Double Star
  - Passive Optical Network (PON)
  - Star-Bus
- Cable Loop Carrier - 500 (CLC-500)
- Asymmetrical Digital Subscriber Line (ADSL).



Classic Copper

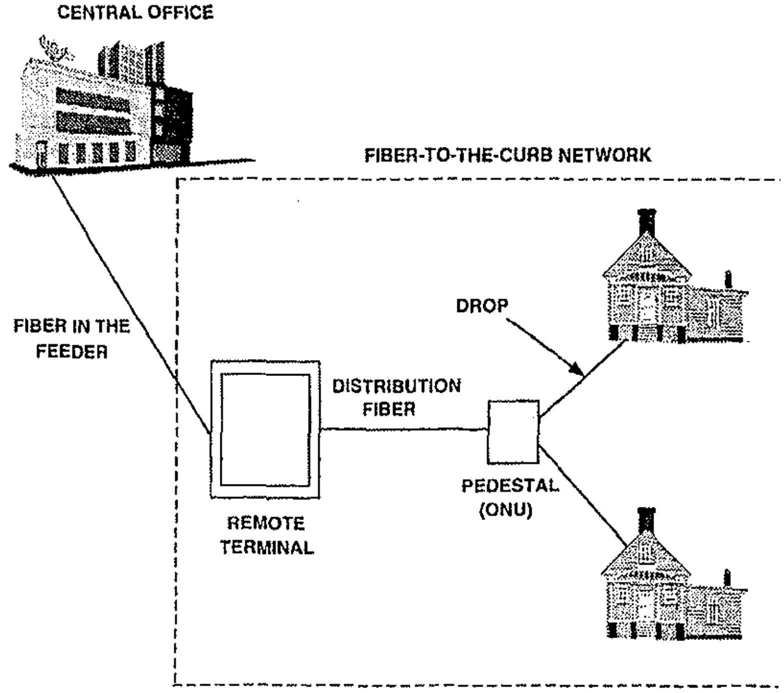


Conditioned Copper Primary + DLC Copper Secondary

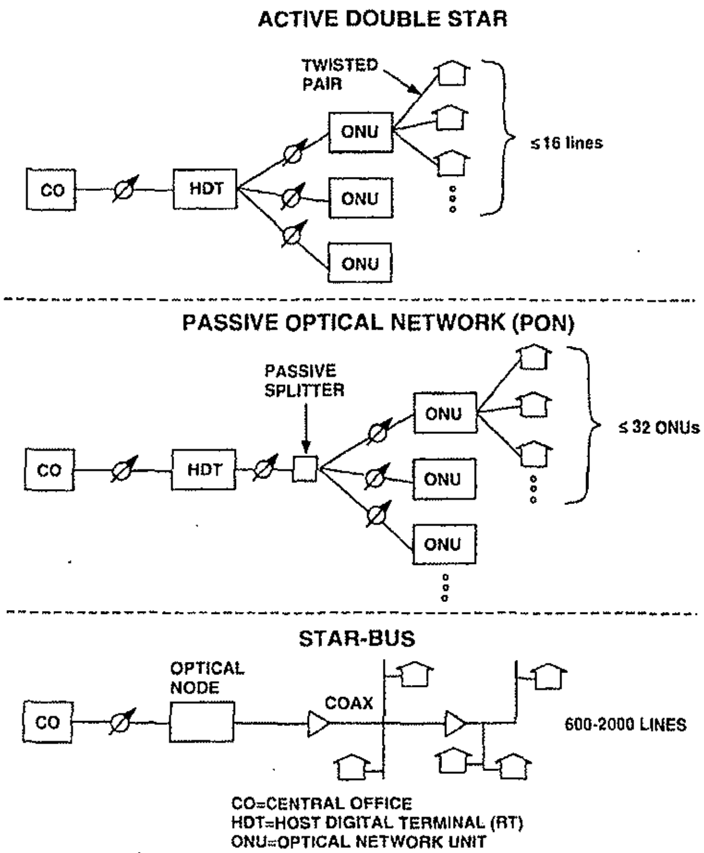


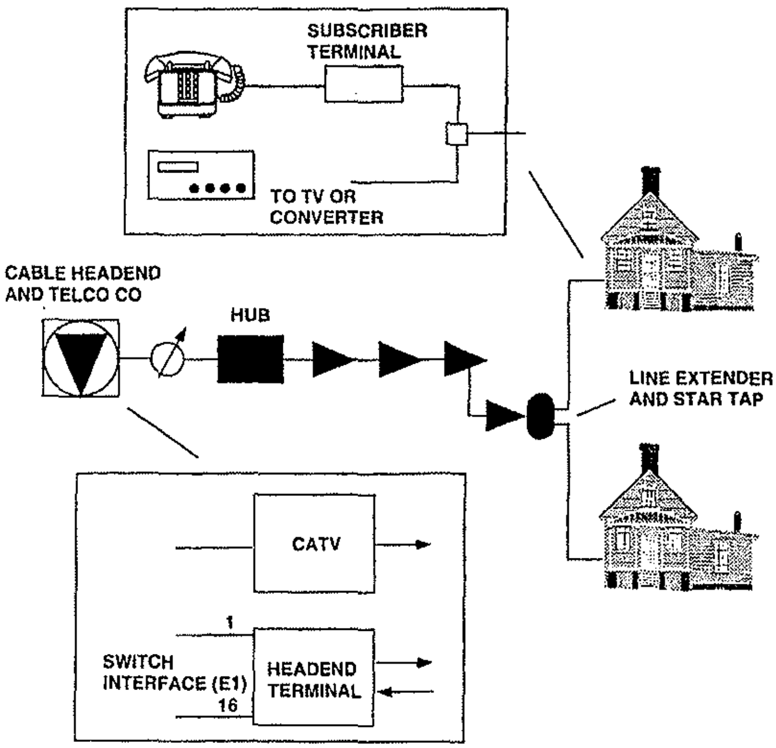
Fiber Primary + DLC Copper Secondary

Fiber Primary + RISLU Copper Secondary



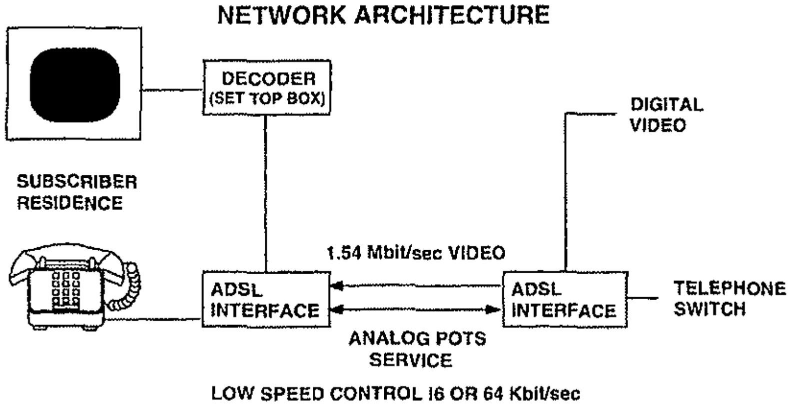
Fiber-to-the-Curb Network


ACTIVE DOUBLE STAR
TWISTED PAIR
CO
HDT
ONU
ONU
ONU
≤16 lines
PASSIVE OPTICAL NETWORK (PON)
PASSIVE SPLITTER
CO
HDT
ONU
ONU
ONU
≤ 32 ONUs
STAR-BUS
OPTICAL NODE
CO
COAX
600-2000 LINES
CO=CENTRAL OFFICE
HDT=HOST DIGITAL TERMINAL (RT)
ONU=OPTICAL NETWORK UNIT



Cable Loop Carrier - 500 (CLC-500)

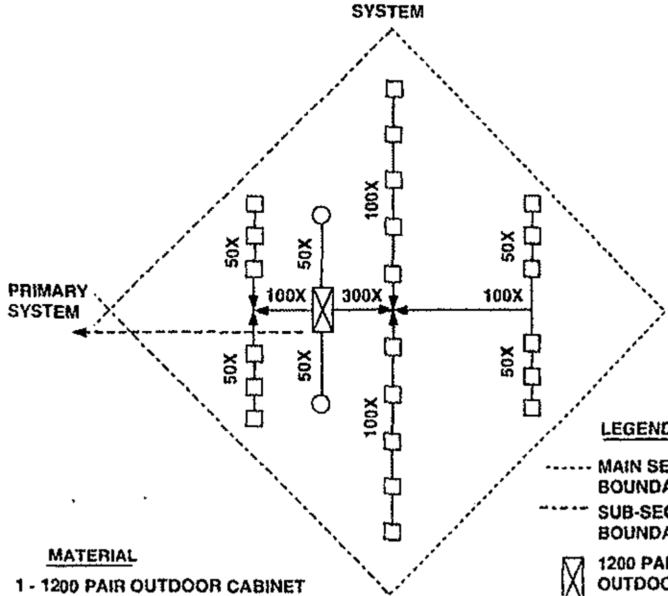
NETWORK ARCHITECTURE



Asymmetrical Digital Subscriber Line (ADSL)

Examples of Secondary (Distribution) Models include:

- Low-Density Copper (Sample Solution)
- High-Density Copper (Sample Solution)
- Low-Density PON 64 (Sample Solution)
- Hybrid Fiber Optic/Coax Network
- Multi-Services Distant Terminal Passive Optical Network (MSDT PON).



LEGEND

- MAIN SECONDARY BOUNDARY
- SUB-SECONDARY BOUNDARY
- 1200 PAIR OUTDOOR CABINET
- 10 PAIR PEDESTAL DISTRIBUTION POINT
- CABLE SPLICE
- 20 PAIR WALL DISTRIBUTION POINT

MATERIAL

1 - 1200 PAIR OUTDOOR CABINET
2 - 20 PAIR WALL DISTRIBUTION POINT
22 - 10 PAIR PEDESTAL DISTRIBUTION POINT
1350 M - 50 PAIR CABLE
1730 M - 100 PAIR CABLE
225 M - 300 PAIR CABLE
33KM - BURIED SERVICE WIRE

Low-Density Copper